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(54) Improvements in and relating to antennae for a portable telephone equipment

Verbesserungen in Zusammenhang mit Antennen eines tragbaren Telefongeräts

Améliorations relatives aux antennes pour un équipement téléphonique portable

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(56) References cited:
DE-A- 3 302 876
DE-A- 3 309 832
DE-A- 3 738 828
US-A- 4 313 119
US-A- 4 471 493
US-A- 4 644 366
US-A- 4 694 301

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Description

This invention relates to antennae and in particular to high-performance antennae for use in hand-held and similar portable equipment such as hand-held radio telephones.

The specific application of this invention is in a CT2 digital cordless telephone operating at 864-868 MHz. The style of the phone is a small handset, with a hinged flap which opens to reveal a keypad. When the handset is not in use, the flap is closed to reduce the phone size and conceal the keypad.

Figures 1 and 2 of the accompanying drawings show a typical handset, one or more of which may be potentially in communication with a base unit (not shown) incorporating a transceiver, together with interface circuitry for connection to an associated telephone network. The handset electronics, including a transceiver and associated antenna for communicating with the base unit, is contained within a housing 1 of plastics material. A hinged flap 2, shown in the open position in Figure 2, allows access to a keypad 3.

In such a system, it is clear that radio performance will be inherently degraded by placing the handset against an obstacle. In the case of a telephone, the handset is always against the users head when the phone is in use. This causes attenuation which is especially apparent at high frequencies, such as those of cellular and CT2 systems. It is possible to add an external antenna to the handset to reduce the effect by moving the antenna a small distance away from the head. This invention specifically provides an antenna system within the body of the handset, providing improved performance without the need for an external antenna. It also efficiently provides antenna switching without the need for any additional components.

US-A-4,694,301 describes a singular antenna arrangement for use with a portable telephone comprising a housing made, at least in part, of insulating material on which are mounted, perpendicularly to one another, a radiator conductor and a ground-plane conductor each comprising rectangular strips of conductive material fed from one end.

US-A-4,313,119 describes a dual mode antenna for use with a miniature radio transceiver, in which a part of the antenna is formed on a flap which is pivotal with respect to the main part of the casing for the radio transceiver on which the other parts of the antenna are formed. The flap is movable relative to the main part of the casing between two positions whereby the shape of the dual mode antenna changes between the two different positions, from a dipole antenna shape to a U-shape, the different shapes being particularly suited to different modes of operation of the radio transceiver.

In accordance with the present invention, there is provided portable electronic apparatus comprising a housing formed in two sections which are movable with respect to one another between a first and a second relative position of said sections, said housing containing electronic circuitry including an antenna system, said antenna system comprising a first antenna mounted on one of said sections and a second antenna mounted on the other of said sections, and wherein said first and second antennae are connected to said electronic circuitry via the same node, said apparatus being characterised in that, in said first relative position of said sections, the first antenna is spaced from the electronic circuitry, and is adjusted so as to be a good electrical match to the electronic circuitry in this position, and in said second relative position of said sections, the first antenna is relatively closer to the electronic circuitry such that its proximity to that circuitry detunes the antenna and causes it to be electrically mismatched to the electronic circuitry.

In order that the invention may be better understood, an embodiment thereof will now be described by way of example only and with reference to the accompanying drawings in which:-

Figures 1 and 2 are perspective views of a telephone handset typical of the type of apparatus with which the present invention is concerned;
Figure 3 is a diagrammatic perspective view showing a first embodiment of the antenna of the present invention, built into the flap of the handset illustrated in Figures 1 and 2;
Figures 4 and 5 are partial front and side edge views respectively of the handset housing, showing diagrammatically a second antenna; and
Figure 6 is a diagrammatic perspective view showing an alternative embodiment of the flap antenna.

Figures 3 to 5 show a first embodiment of the invention in which a pair of antennae, fed from a common node in the transceiver circuitry, are mounted respectively on the flap 2 (Figure 3) and in the housing 1 (Figures 4 and 5).

In order to reduce the effect of placing the handset against the head, the main antenna is built into the end of the flap 2. The antenna is planar in construction and, in the embodiment illustrated, comprises a monopole 4 over a groundplane 5, fed by a coaxial feed 6 from the handset transceiver circuitry. The active element 4 is laid parallel to the groundplane 5 due to space constraints, which differs from a standard monopole which is positioned perpendicular to the groundplane. The antenna looks inductive and so is capacitively matched by means of capacitors C. Now with the phone in use, the flap 2 is located away from the head and this is enough to greatly reduce the adverse proximity effects. Antenna performance comparable with an external antenna is achieved.

A drawback of the flap antenna is apparent when the flap is closed (when the phone is not in use). In this position the rest of the transceiver circuitry is situated over the antenna, providing a very effective screen from any incoming signals. The antenna performance is thus

unacceptably degraded.

To overcome this problem, an embodiment of the invention provides that a second antenna is built into one end of the main body of the handset (the bottom, in this case). The internal antenna design used in the example illustrated is similar to the flap antenna 4/5, and is shown in Figures 4 and 5. A copper strip 7 is laid at the bottom of the handset, parallel to the groundplane 8 provided by the internal circuit boards. The length of the strip 7 is approximately a 1/4 wavelength, and is tuned with series inductance L. The second antenna is fed from the electronic circuitry via a terminal 10, which connects to one end of inductance L. The other end of inductance L connects to one end of the strip 7. This internal antenna performs much better than the flap antenna when the flap is closed. However, the reverse is true when the phone is in use against the head. The close proximity of the head, and also the tendency of the user to hold the end of the phone both cause power to be absorbed.

To obtain optimum performance, the antennae are joined at a common node and switched on and off depending on the status of the phone. With the phone in use, only the flap antenna is selected, while with the flap shut, only the internal antenna is used.

Antenna switching may be realised in several ways. Most involve extra circuitry (more space) and current (shorter battery life). Both of these are at a premium in a hand-held product. This invention realises antenna switching with no extra components: it relies on the careful design of the antenna impedances.

The flap antenna 4/5 is designed to have a good match to the connecting handset circuitry so that all the power is transferred when the flap 2 is open and the phone is in use. When the flap is closed, the proximity of the rest of the handset circuitry causes additional capacitance between the flap antenna active element 4 and the groundplane 5. This causes the antenna to be detuned, the effect of which is to change the antenna impedance to a bad mismatch at the required frequency. This in turn causes most of the power to be reflected back from the antenna. This means that the antenna is electrically switched off but without any need for switching components.

The antenna mismatch has been carefully designed so that the flap antenna appears to be an open circuit when the flap is closed. This is realised by connecting the flap antenna to the handset with a length of 50 ohm line which transforms the arbitrarily mismatched antenna to an open circuit. This allows a second, well matched antenna to be connected at the same node without experiencing any interference from the (turned-off) flap antenna. Thus when the flap is closed, all the power is diverted to this second antenna, which is the internal antenna 7/8.

However, with the internal and flap antennae connected to the same node, there is a problem when the phone is in use. Now the flap antenna 4/5 and the internal antenna 7/8 both look like a good match for the handset circuitry, so half the power is split between each of the internal and flap antennae. As the internal antenna performs badly next to the head, putting half the power into it can be considered wasted power relative to the flap antenna. The flap antenna is also operating at half power, so this has been degraded. To realise good phone performance when the flap is open, the internal antenna must be turned off. Without the need for switching circuits, this can be realised in two ways.

The first way is to introduce a deliberate impedance mismatch between the internal and flap antennae. For example, the internal antenna impedance may be made significantly higher than that of the flap antenna. When the flap 2 is open, the power delivered to the flap antenna is greater than that in the internal antenna by a ratio equal to the inverse of the relative antenna impedances. When the flap is closed, the flap antenna is open circuit, so there is only power delivered to the internal antenna. Due to the mismatch, there is a slight loss of internal antenna efficiency. In an example, the internal antenna impedance is raised to a typical value of double that of the matched flap antenna. When the flap is closed, the flap antenna still appears open circuit, and the 2:1 mismatch between the handset and the internal antenna causes an acceptable loss. When the flap is open, the 1:2 impedance ratio causes twice as much power to flow in the flap antenna as in the internal antenna. This restores the flap antenna performance to an acceptable level, while reducing the contribution from the redundant internal antenna.

The second way is to introduce a mechanical tuning element to the internal antenna (see Figure 6). The element is extra groundplane 9 placed near the internal antenna at the bottom of the flap. As for the flap antenna, when the flap is opened, this element moves so that the relative capacitance between the internal antenna and the flap changes, causing a detuning effect. This mismatch causes less power to be radiated in the internal antenna, increasing the effectiveness of the flap antenna.

Claims

1. Portable electronic apparatus comprising a housing (1) formed in two sections which are movable with respect to one another between a first and a second relative position of said sections, said housing (1) containing electronic circuitry including an antenna system (4,5,6,7,8,10), said antenna system comprising a first antenna (4,5) mounted on one of said sections (2) and a second antenna (7,8) mounted on the other of said sections, and wherein said first and second antennae are connected to said electronic circuitry via the same node, said apparatus being characterised in that, in said first relative position of said sections, the first antenna (4,5) is

spaced from the electronic circuitry, and is adjusted so as to be a good electrical match to the electronic circuitry in this position, and in said second relative position of said sections, the first antenna (4,5) is relatively closer to the electronic circuitry such that its proximity to that circuitry detunes the antenna and causes it to be electrically mismatched to the electronic circuitry.

2. Portable electronic apparatus as claimed in claim 1, wherein said first antenna (4,5) comprises an active element (4) and a groundplane (5), said active element (4) comprising a length of conductive material disposed parallel to the groundplane (5) and fed from one end.

3. Portable electronic apparatus as claimed in claim 2 wherein capacitor means (1) are connected between the active element (4) and groundplane (5) of said first antenna in order to capacitively match the antenna (4,5).

4. Portable electronic apparatus as claimed in either one of claims 3 or 4 wherein the first antenna (4,5) is mounted on a sheet of insulating material forming part of said housing (1), and comprises a first rectangular sheet of conductive material forming said groundplane (5), and a second, elongate, rectangular sheet of conductive material forming said active element (4).

5. Portable electronic apparatus as claimed in claim 4 wherein said sheet forms part of said one (2) of said sections, and wherein said other of said sections contains said electronic circuitry.

6. Portable electronic apparatus as claimed in any one of the preceding claims wherein said two sections are hingedly connected together.

7. Portable electronic apparatus as claimed in any one of the preceding claims wherein said second antenna (7,8) comprises an active element (7) and a groundplane (8), said active element (7) comprising a length of conductive material disposed parallel to the groundplane (8) and fed from one end.

8. Portable electronic apparatus as claimed in claim 7 wherein said second antenna is mounted on a sheet of insulating material and comprises a first rectangular sheet of conductive material forming said groundplane (8) and a second, elongate, rectangular sheet of conductive material forming said active element (7).

9. Portable electronic apparatus as claimed in claim 8 wherein the sheet forming the groundplane (8) of the second antenna further forms a groundplane (8) for said electronic circuitry.

10. Portable electronic apparatus as claimed in either one of claims 8 or 9 including inductance tuning means placed in series with the active element (7) of said second antenna.

11. Portable electronic apparatus as claimed in any one of the preceding claims wherein the mismatch of the first antenna (4,5) is such as to exhibit an open circuit to the electronic circuitry.

12. Portable electronic apparatus as claimed in any one of the preceding claims wherein said first (4,5) and second (7,8) antennae are designed such that there is an electrical mismatch between them, as seen by the electronic circuitry.

13. Portable electronic apparatus as claimed in claim 12 wherein the characteristic impedance of one of said antennae (7,8) is significantly higher than that of the other (4,5).

14. Portable electronic apparatus as claimed in claim 12 wherein a mechanical tuning element (9) is attached for movement with one of said sections of the housing (1), said tuning element (9) being positioned such that, as the two sections are moved with respect to one another, the element (9) detunes one of the antennae (7,8), but not the other, thus introducing an electrical mismatch between them.

15. Portable electronic apparatus as claimed in any one of the preceding claims in the form of a handset (1) for a cordless telephone apparatus, wherein said other of said sections comprises the main housing section incorporating transceiver circuitry and a telephone keypad, and wherein said one of said sections (2) forms a flap (2) pivotally mounted with respect to the main housing section, and operable to cover the keypad (3) when the handset (1) is not in use.

Patentansprüche

1. Tragbare elektronische Vorrichtung, umfassend ein Gehäuse (1), welches in zwei Abschnitten ausgebildet ist, welche im Verhältnis zueinander zwischen einer ersten und einer zweiten Relativposition der Abschnitte beweglich sind, wobei das Gehäuse (1) elektronische Schaltungen enthält, einschließlich eines Antennensystems (4,5,6,7,8,10), und das Antennensystem eine erste Antenne (4,5) umfaßt, die an einem der Abschnitte (2) angebracht ist, und eine zweite Antenne (7,8), welche an dem anderen Abschnitt angebracht ist, und wobei die ersten und zweiten Antennen mit den elektronischen

Schaltungen über den gleichen Knoten verbunden sind, und die Vorrichtung dadurch gekennzeichnet ist, daß die erste Antenne (4,5) in der ersten Relativposition der Abschnitte von den elektronischen Schaltungen beabstandet und so eingestellt ist, daß sie in dieser Position an die elektronischen Schaltungen elektrisch gut angepaßt ist, und die erste Antenne (4,5) in der zweiten Relativposition relativ näher an den elektronischen Schaltungen ist, so daß ihre Nähe zu den Schaltungen die Antenne verstimmt und bewirkt, daß sie gegenüber den elektronischen Schaltungen elektrisch fehlangepaßt ist.

2. Tragbare elektronische Vorrichtung nach Anspruch 1, in welcher die erste Antenne (4,5) ein Aktivelement (4) und eine Erdplatte (5) umfaßt, wobei das Aktivelement (4) eine Länge von leitfähigem Material umfaßt, welche parallel zur Erdplatte (5) angeordnet ist und von einem Ende gespeist wird.

3. Tragbare elektronische Vorrichtung nach Anspruch 2, in welcher eine Kondensatorvorrichtung (1) zwischen dem Aktivelement (4) und der Erdplatte (5) der ersten Antenne angeschlossen ist, um die Antenne (4,5) kapazitiv anzupassen.

4. Tragbare elektronische Vorrichtung nach Anspruch 3 oder 4, in welcher die erste Antenne (4,5) auf einer Lage isolierenden Materials montiert ist, welche ein Teil des Gehäuses (1) bildet, und eine erste rechteckige Lage aus leitfähigem Material umfaßt, welche die Erdplatte (5) bildet, und eine zweite, gestreckte rechteckige Lage aus leitfähigem Material, welche das Aktivelement (4) bildet.

5. Tragbare elektronische Vorrichtung nach Anspruch 4, in welcher die Lage einen Teil der einen (2) der Abschnitte bildet, und wobei der andere der Abschnitte die elektronischen Schaltungen enthält.

6. Tragbare elektronische Vorrichtung nach einem der vorhergehenden Ansprüche, in welcher die zwei Abschnitte klappbar verbunden sind.

7. Tragbare elektronische Vorrichtung nach einem der vorhergehenden Ansprüche, in welcher die zweite Antenne (7,8) ein Aktivelement (7) und eine Erdplatte (8) umfaßt, wobei das Aktivelement (7) eine Länge von leitfähigem Material umfaßt, die parallel zu der Erdplatte (8) angeordnet ist, und von einem Ende gespeist wird.

8. Tragbare elektronische Vorrichtung nach Anspruch 7, in welcher die zweite Antenne auf einer Lage von isolierendem Material montiert ist, und eine erste rechteckige Lage aus leitfähigem Material umfaßt, welche die Erdplatte (8) bildet, und eine zweite, gestreckte rechteckige Lage aus leitfähigem Material, welche das Aktivelement (7) bildet.

9. Tragbare elektronische Vorrichtung nach Anspruch 8, in welcher die Lage, welche die Erdplatte (8) der zweiten Antenne bildet, ferner eine Erdplatte (8) für die elektronischen Schaltungen bildet.

10. Tragbare elektronische Vorrichtung nach Anspruch 8 oder 9, welche eine Induktivitäts-Abstimmvorrichtung enthält, die in Reihe mit dem Aktivelement (7) der zweiten Antenne angeordnet ist.

11. Tragbare elektronische Vorrichtung nach einem der vorhergehenden Ansprüche, in welcher die Fehlanpassung der ersten Antenne (4,5) so ist, daß sie gegenüber den elektronischen Schaltungen als offene Leitung erscheint.

12. Tragbare elektronische Vorrichtung nach einem der vorhergehenden Ansprüche, in welcher die erste (4,5) und zweite (7,8) Antenne so entworfen sind, daß zwischen ihnen eine elektrische Fehlanpassung besteht, aus Sicht der elektronischen Schaltungen.

13. Tragbare elektronische Vorrichtung nach Anspruch 12, in welcher die charakteristische Impedanz einer der Antennen (7,8) bedeutend höher ist als jene der anderen (4,5).

14. Tragbare elektronische Vorrichtung nach Anspruch 12, in welcher ein mechanisches Abstimmelement (9) angebracht ist, um sich mit einem der Abschnitte des Gehäuses (1) zu bewegen, wobei das Abstimmelement (9) so positioniert ist, daß während die zwei Abschnitte gegeneinander bewegt werden, das Element (9) eine der Antennen (7,8) verstimmt, aber nicht die andere, wodurch eine elektrische Fehlanpassung zwischen ihnen eingeführt wird.

15. Tragbare elektronische Vorrichtung nach einem der vorhergehenden Ansprüche, in der Form eines Handgeräts (1) für eine schnurlose Telefonvorrichtung, in welcher der andere der Abschnitte den Hauptgehäuseabschnitt umfaßt, welcher Sender-empfänger-Schaltungen und eine Telefontastatur enthält, und wobei der eine der Abschnitte (2) eine Klappe (2) bildet, welche bezüglich dem Hauptgehäuseabschnitt schwenkbar angebracht ist, und die Tastatur (3) abdecken kann, wenn das Handgerät (1) nicht benutzt wird.

Revendications

1. Appareil électronique portable comprenant un boîtier (1) constitué de deux parties mobiles l'une par rapport à l'autre, entre une première et une deuxiè-

me positions relatives desdites parties, ledit boîtier (1) contenant des circuits électroniques comportant un système d'antennes (4, 5, 6, 7, 8, 10), ledit système d'antennes comprenant une première antenne (4, 5) montée sur l'une desdites parties (2), et une deuxième antenne (7, 8) montée sur l'autre desdites parties, et dans lequel lesdites première et deuxième antennes sont connectées auxdits circuits électroniques par l'intermédiaire du même noeud, ledit appareil étant caractérisé en ce que, dans ladite première position relative desdites parties, la première antenne (4, 5) est séparée des circuits électroniques, et est réglée de manière à constituer une bonne adaptation électrique avec les circuits électroniques dans cette position, et dans ladite deuxième position relative desdites parties, la première antenne (4, 5) est relativement plus proche des circuits électroniques, de sorte que sa proximité avec ces circuits désaccorde l'antenne et la rend électriquement désadaptée aux circuits électroniques.

2. Appareil électronique portable selon la revendication 1, dans lequel ladite première antenne (4, 5) comprend un élément actif (4) et un plan de masse (5), ledit élément actif (4) comprenant une certaine longueur d'un matériau conducteur disposé parallèlement au plan de masse (5) et alimenté par une extrémité.

3. Appareil électronique portable selon la revendication 2, dans lequel des moyens de condensateur (1) sont connectés entre l'élément actif (4) et le plan de masse (5) de ladite première antenne, pour adapter l'antenne (4, 5) de manière capacitive.

4. Appareil électronique portable selon l'une ou l'autre des revendications 2 ou 3 dans lequel la première antenne (4, 5) est montée sur une feuille de matériau isolant faisant partie dudit boîtier (1), et comprend une première feuille rectangulaire de matériau conducteur formant ledit plan de masse (5), et une deuxième feuille rectangulaire allongée de matériau conducteur formant ledit élément actif (4).

5. Appareil électronique portable selon la revendication 4, dans lequel ladite feuille fait partie de ladite une (2) desdites parties, et dans lequel ladite autre desdites parties contient lesdits circuits électroniques.

6. Appareil électronique portable selon l'une quelconque des revendications précédentes, dans lequel lesdites deux parties sont connectées ensemble de manière articulée.

7. Appareil électronique portable selon l'une quelconque des revendications précédentes, dans lequel ladite deuxième antenne (7, 8) comprend un élément actif (7) et un plan de masse (8), ledit élément actif (7) comprenant une certaine longueur d'un matériau conducteur disposé parallèlement au plan de masse (8) et alimenté par une extrémité.

8. Appareil électronique portable selon la revendication 7, dans lequel ladite deuxième antenne est montée sur une feuille de matériau isolant, et comprend une première feuille rectangulaire de matériau conducteur formant ledit plan de masse (8), et une deuxième feuille rectangulaire allongée de matériau conducteur formant ledit élément actif (7).

9. Appareil électronique portable selon la revendication 8, dans lequel la feuille formant le plan de masse (8) de la deuxième antenne forme en outre un plan de masse (8) pour lesdits circuits électroniques.

10. Appareil électronique portable selon l'une ou l'autre des revendications 8 ou 9, comportant des moyens d'accord à inductance placés en série avec l'élément actif (7) de ladite deuxième antenne.

11. Appareil électronique portable selon l'une quelconque des revendications précédentes, dans lequel la désadaptation de la première antenne (4, 5) est telle qu'elle présente un circuit ouvert aux circuits électroniques.

12. Appareil électronique portable selon l'une quelconque des revendications précédentes, dans lequel ladite première (4, 5) et ladite deuxième (7, 8) antennes sont conçues de façon qu'il existe une désadaptation électrique entre elles, telles que vues depuis les circuits électroniques.

13. Appareil électronique portable selon la revendication 12, dans lequel l'impédance caractéristique de l'une desdites antennes (7, 8) est sensiblement supérieure à celle de l'autre (4, 5).

14. Appareil électronique portable selon la revendication 12, dans lequel un élément d'accord mécanique (9) est fixé pour un mouvement avec l'une desdites parties du boîtier (1), ledit élément d'accord (9) étant positionné de façon que, lorsque les deux parties sont déplacées l'une par rapport à l'autre, l'élément (9) désaccorde l'une des antennes (7, 8), mais pas l'autre, introduisant ainsi une désadaptation électrique entre elles.

15. Appareil électronique portable selon l'une quelconque des revendications précédentes, sous la forme d'un combiné (1) pour un appareil téléphonique sans fil, dans lequel ladite autre desdites parties comprend la partie de boîtier principal contenant les

circuits d'émetteur-récepteur, et un clavier téléphonique, et dans lequel ladite une desdites parties (2) forme un rabat (2) monté de manière pivotante par rapport à la partie de boîtier principal, et pouvant être actionné pour recouvrir le clavier (3) lorsque le combiné (1) n'est pas utilisé.

Fig.1

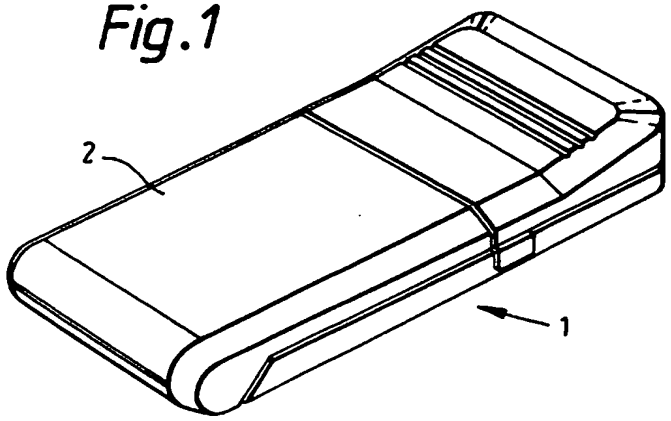

Fig.2

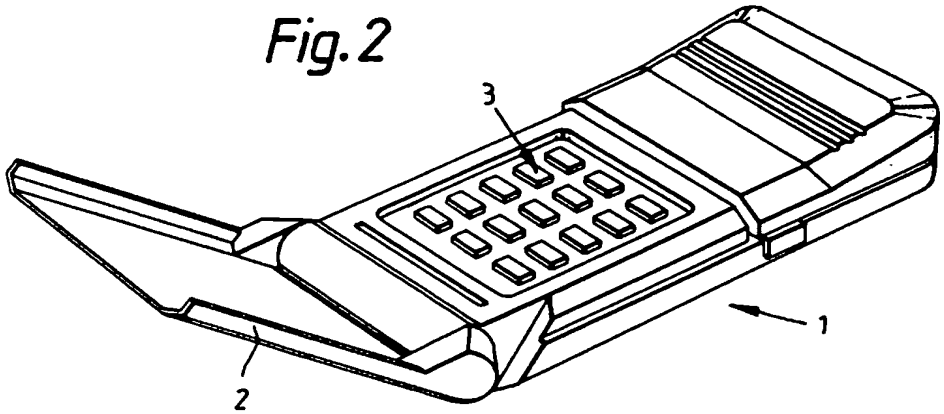

Fig.3

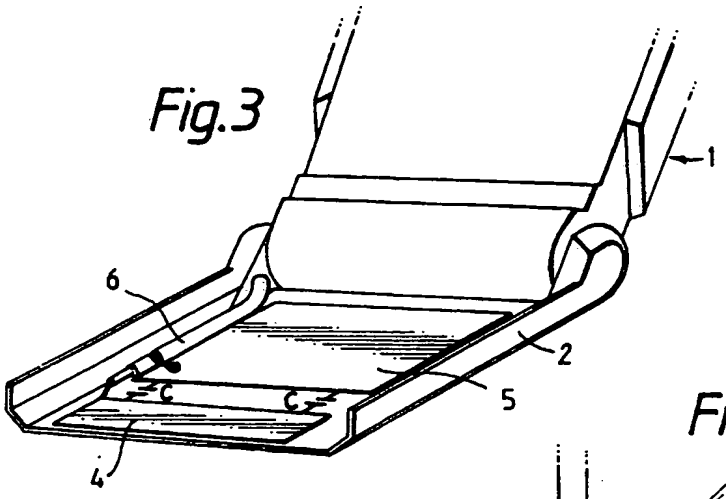

Fig.4

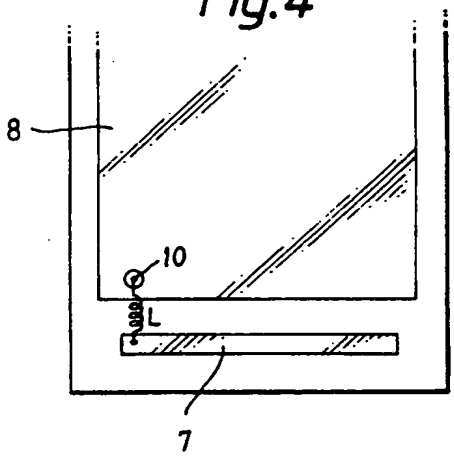

Fig.5

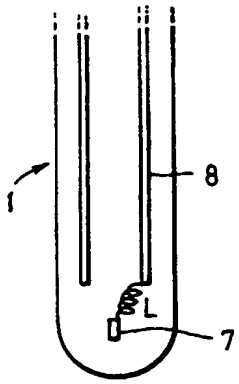

Fig.6